ABSTRACT

The advantages of Steel Fibre Reinforced Concrete (SFRC) over plain concrete has been the motive for the extensive research taking place in this field. The addition of randomly dispersed short steel fibres to the conventional concrete, significantly increases not only the tensile and flexural strengths but also its ductility. However the gains have to be optimized through a proper mix design procedure. Though, studies on fibre reinforced concrete have been carried out extensively by various researchers, so far there is no standard procedure for design of SFRC mixes. It is felt that the conventional methods of design of concrete mixes may not be suitable for steel fibre reinforced concrete (SFRC) mixes, because with the addition of fibres more water content is needed for achieving the same workability. Hence, a new water-cement ratio law has to be established for fibre reinforced concrete. Further, the strength and workability properties of FRC mixes are greatly influenced by several parameters viz. Fibre material, volume percentage of fibres, fibre aspect ratio, ratio of fine aggregate to coarse aggregate, aggregate/cement ratio and water/cement ratio etc., Consequently, developing a macro-mechanical model for SFRC mixes requires an extensive understanding of the relation between these parameters and the properties of the resulting mix.

Developing empirical or semi-empirical formulae for macro-mechanical modelling of SFRC is rather difficult due to the highly non-linear interaction among the above mentioned parameters. Further, the degree of non-linearity and the extent of interaction of the constituent parameters is also not clearly known. In this thesis, an alternative method of machine learning using Artificial Neural Networks (ANN) for predicting the workability and strength properties of SFRC mixes is presented. In this method, the computer automatically gathers the knowledge embodied in the examples presented to it during training. Therefore, no parameters need to be set by trail and error. The basic advantage of using the ANN approach lies in the fact that it is a model free estimator. Therefore, it does not require any external manifestation of parametric relationship. Therefore, complicated relationship between various parameters are mapped automatically by the network.

For the present study a feed forward from of artificial neural net work has been trained to act as a macro-mechanical model for SFRC. Training examples for the ANN have been generated by conducting compaction factor tests for workability and cube compression, split cylinder and flexural strength tests on 66 different SFRC mixes with varying water/cement ratios, aggregate cement ratios, volume percentage of fibres, and aspect ratios. The final configuration of the network consists of 4 input nodes, 4 output nodes and 15 nodes each in two hidden layers (4-15-15-4). After successful training the network has predicted accurately the compaction factor, compressive strength, flexural strength and tensile strength of new SFRC mixes. Various stages in the development of a neural network macro- mechanical model viz.generation of training examples, selection of a network type, selection of the input and output vector for the network, arriving at a suitable network configuration, training of the network, validation of the model have been presented in detail.
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